

## **PC-II**

# **Development of Missing Environmental Quality Standards and Revision of Existing Standards**



**August, 2021**

Cost: Rs. 71.40 Million  
Gestation Period: FY 2021-23

**ENVIRONMENT PROTECTION DEPARTMENT,  
GOVERNMENT OF THE PUNJAB**

## PC- II FORM

1	<b>Name by which survey/ feasibility will be identified</b>	Development of Missing Environmental Quality Standards and Revision of Existing Standards
2	<b>Administrative authorities responsible for</b>	
	<b>i) Sponsoring</b>	Environment Protection Department (EPD), Government of the Punjab, Lahore.
	<b>ii) Execution</b>	Strategic Planning & Implementation Unit (SP&IU), EPD Government of the Punjab, Lahore.
3	<b>Details of survey/feasibility study</b>	
	<b>i) General description and justification</b>	<p>Environmental Protection Agency, Punjab has to implement the provisions of the Punjab Environmental Protection Act, 1997 for the protection, conservation, rehabilitation and improvement of the environment, for the prevention and control of pollution, and promotion of sustainable development. Section 11 (1) of the Act <i>ibid</i> states as under: “<b>Prohibition of certain discharges or emissions.</b>– (1) Subject to the provisions of this Act and the rules and regulations made there under no person shall discharge or emit or allow the discharge or emission of any effluent or waste or air pollutant or noise in an amount, concentration or level which is in excess of the Punjab Environmental Quality Standards or, where applicable, the standards established under clause (g) of sub-section (1) of section 6.”</p> <p><b>Background</b></p> <p>Pakistan Environmental Protection Council notified under the Pakistan Environmental Protection Act, 1997 in its first meeting held on 10<sup>th</sup> May 1993 approved the National Environmental Quality Standards (NEQS). The approved NEQS were uniform standards applicable to all kinds of industrial and municipal effluents. There are 32 parameters prescribing permissible levels of pollutants in liquid effluent while 16 parameters for gaseous emissions. In April 1996, the Pakistan Environmental Protection Council set up an Environmental Standards Committee (ESC) headed by Mr. Shams Kasim Lakha to review, inter alia, the NEQS and suggest changes where necessary, based on conditions</p>

	<p>in Pakistan. The committee realized that some of the parameters were more stringent than other Countries of the region, so the task of the rationalization of NEQS was referred to an Expert Advisory committee to review and suggest changes, if and where required. Before initiating the task, the Expert Committee was expanded to include representatives of trade and industry. The Expert Committee identified ten parameters – eight (8) liquid effluent viz. BOD; COD; TDS; Chloride; Sulphide; Chromium; Ammonia; and Temperature, and two (2) gaseous emissions viz. SO<sub>2</sub> (Sulphur di oxide) and NO<sub>x</sub> (Oxides of Nitrogen) for review. After consultation with various organizations the NEQS Expert Advisory Committee completed its task and proposed it to the ESC. Finally, the Environmental Standards Committee endorsed the proposed revised NEQS and the Pakistan Environmental Protection Council was recommended to approve the revised draft NEQS. In December 28, 1999, PEPC approved the revised NEQS.</p> <p>Following the 18<sup>th</sup> Amendment, 2010, management of the environment has been delegated from the federal level to the provinces. Punjab Environmental Protection Council in its first meeting held on 18.03.2016 adopted the NEQS and approved standards for medical waste. Thus, there are following seven Punjab Environmental Quality Standards for (i) Municipal and liquid Industrial Effluents (ii) Industrial Gaseous Emissions (iii) Motor Vehicle Exhaust and Noise (iv) Ambient Air (v) Drinking Water (vi) Ambient Noise and (vii) Treatment of liquid and disposal of medical waste.</p> <p>Due to uncontrolled urbanization and industrial evolution, environmental degradation has been occurring very rapidly and causing many problems primarily effecting air, water, soil. Water pollution specifically in regions where factories are built next to natural water sources. These toxins can come in a variety of forms — solid, liquid or gaseous — and they can all end up contaminating the ground and surface water bodies. Even landfills and other waste disposal points can leach toxins into the local water supply, leading to water pollution. Soil contamination is another problem that goes hand in hand with industrialization. Heavy metals and toxic chemicals can also leach into the soil and, in turn, contaminate crops that grow there. Another issue is air</p>
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	<p>pollution, caused by the smoke and emissions generated by the industries.</p> <p>Although it is impossible to restrict this urbanization and control the industrial expansion, however, it could be ensured by setting the quality standards and their enforcement. As quality standards in Punjab are developed for controlling this increasing pollutions but are generalized applicable to both the industrial effluents and municipal waste water. Therefore, there is dire need to review all these enlisting Environmental Quality Standards (EQSs) and formulation of missing and industry specific EQSs for the effective implementation of Punjab Environmental Protection Act, 2012 for the conservation, preservation and promotion of sustainable development for the environment. In addition to this, following are the major reasons for revision:</p> <ul style="list-style-type: none"> <li>• Punjab Environmental Protection Council had opted the Federally notified standards <i>mutatis mutandis</i>.</li> <li>• Latest innovation and industrialization trends require reconsideration regarding the criteria pollutants and emission levels.</li> <li>• New environmental pollution episodes like smog etc. necessitates the re-evaluation of yard sticks earlier defined in the absence of such episodes.</li> </ul> <p><b>Rationalization</b></p> <p>Purpose of revising and formulation of missing &amp; industry specific Environmental Quality Standards is to develop a framework for deriving environmental quality standards and to develop guidelines regarding threshold limits of pollutants / effluents to control health hazards. These environment quality standards are notified as legally binding minimum standard to protect the environment. It may be expressed either as concentration of a substance in the effluent or as a load (mass) discharged per unit of production, and may not be exceeded during one or more periods of time. Furthermore, emission limit values should take into account the local environmental conditions and thus, the relevant EQSs. Emission limit values can be set for the specific industrial sector, the specific environmental medium, or both. Compliance with the EQSs will benefit both the public and the environment.</p>
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	<p>Furthermore, many countries have evolved from equivocally implementable environmental quality standards and formulated the industry specific environmental quality standards. Following is the example of some countries who have notified the industry specific environmental quality standards.</p> <p>Germany has notified various ordinances on requirements for the discharge of wastewater into waters and it includes regulation on domestic and municipal wastewater.</p> <p>Similarly, Central Pollution Control Board of India has notified industry specific environmental quality standards for almost 114 industries as well as general standards for discharge of environmental pollutants/effluents (load based, concentration based, equipment based).</p> <p>Therefore, in addition to the review of existing PEQS, further environmental quality standards are needed in following areas:</p> <ol style="list-style-type: none"> <li>1. In comparison of pollution load regarding municipal and industrial effluents, parameter should be separated as the impact level is more intensive for industrial effluent. Therefore, permissible limits should be different for both.</li> <li>2. Environmental Quality Standards for Surface water bodies as Chemical pollution of surface water presents a threat to the aquatic environment with effects such as acute and chronic toxicity to aquatic organisms, accumulation in the ecosystem and losses of habitats and biodiversity, as well as a threat to human health. As a matter of priority, causes of pollution should be identified and emissions should be dealt with at source, in the most economically and environmentally effective manner.</li> <li>3. Vibration Standards for anthropogenic and industrial sources</li> <li>4. Reuse/recycling of treated liquid effluent for irrigation/ horticulture purpose</li> </ol> <p>Existing PEQS shall be rationalized for their effective enforcement and facilitation of polluters for taking remedial measures for compliance through designing cost effective pollution control devices/systems/plants. New standards in deficient areas shall be formulated. Therefore, there is a dire need and a huge gap to bridge for implementation of the Act <i>ibid</i> with</p>
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		<p>formulation of industry specific environmental quality standards. EPA Punjab lacks the industry specific environmental quality standards. Initially, in Phase-I, sixteen industries are selected for formulation of industry specific EQSs, based on their magnitude, complexity of manufacturing process, usage of natural resources and their associated environmental impacts (<b>Annex-I</b>).</p>
	<p><b>Objectives &amp; Scope of Project</b></p>	<p>The objectives of this PC-II are in line with objectives as envisaged in the Program Appraisal Document of the Punjab Green Development Program. The EPD and its EPA have so far lacked the structure and resources to effectively carry out several of their environmental management mandates, including environmental clearance of investment proposals and inspection of industries for environmental compliance by devising more active inspection regime for polluting industries to comply with environmental standards and invest in cleaner technologies.</p> <p>As a part of the P4R program, this project aims at rationalization, revision, and development of environmental quality standards, especially development of industry specific standards under DLI-1 of improving EPD Capacity.</p> <p>The main objectives of this project are:</p> <ol style="list-style-type: none"> <li>1- Develop a framework for deriving environmental quality standards;</li> <li>2- Review, rationalize, and revise existing Punjab Environmental Quality Standards (PEQS);</li> <li>3- Formulation of missing Environmental Quality Standards (EQSs)</li> <li>4- Formulation of industry specific environmental quality standards in terms of gaseous emission, effluent discharge, noise &amp; vibration etc.</li> </ol> <p>To meet above stated objectives, two separate consulting firms will be hired, Objective no 2 &amp; 3 will be achieved through consultancy – A and Objective no 4 will be achieved through consultancy – B, as per following scope of project:</p> <p><b><u>Scope of Consultancy - A:</u></b>  Review of existing / notified Punjab Environmental Quality Standards, which are seven in number, for potential revision (if any).</p>

Sr. No	Notification #	Date	Subject
i.	118 of 2016	12 <sup>th</sup> August, 2016	Punjab Environmental Quality Standards for Industrial Gaseous Emissions
ii.	119 of 2016	-do-	Punjab Environmental Quality Standards for Treatment of Liquid and Disposal of Bio-medical Waste
iii.	120 of 2016	-do-	Punjab Environmental Quality Standards for Municipal and Liquid Industrial Effluents
iv.	121 of 2016	-do-	Punjab Environmental Quality Standards for Noise
v.	122 of 2016	-do-	Punjab Environmental Quality Standards for Ambient Air
vi.	123 of 2016	-do-	Punjab Environmental Quality Standards for Motor Vehicle Exhaust and Noise
vii.	124 of 2016	-do-	Punjab Environmental Quality Standards for Drinking Water

For example, quality standards for industrial and municipal effluents are same. But in comparison of pollution load for municipal and industrial effluents, impact level is different and generally more intensive for industrial effluents. Therefore, permissible limits should be different for both and need revision after which there will be separate standards for both industrial and municipal effluents (based on load, concentration, and equipment).

Formulation of missing standards as envisaged under Section 6 (1) (g) of the Act as for the land / soil quality do not exist. However, for the quality of the ambient air, water under Section 6 (1) (g) of the PEPA Act, 2012 are already present.

In addition to it, some of the missing quality standards are enlisted as follows:

1. Environmental Quality Standards for surface water bodies as chemical pollution of surface water presents a threat to the aquatic environment with effects such as acute and chronic toxicity to aquatic organisms, accumulation in the ecosystem and losses of habitats and biodiversity, as well as a threat to human health. As a matter of priority, causes of pollution should be identified and emissions should be

		<p>dealt with at source, in the most economically and environmentally effective manner.</p> <ol style="list-style-type: none"> <li>2. Noise Emission &amp; Vibration Standards</li> <li>3. Land/Soil Quality (Guidelines/ Standards)</li> <li>4. Reuse/recycling of treated liquid effluents and sludge for irrigation/ horticulture purpose</li> <li>5. Review and revision of Environmental Sample Rules, 2001 (for sampling and sample processing methodology).</li> </ol> <p>The consultant will perform following tasks to achieve stated objective</p> <ol style="list-style-type: none"> <li>1. Develop a framework for deriving environmental quality standards;</li> <li>2. Review, rationalize, and revise existing Punjab Environmental Quality Standards (PEQS);</li> <li>3. Develop general standards of discharge of pollutants/effluents (based on load, concentration and equipment)</li> <li>4. Review and revise Environmental Sample Rules, 2001</li> <li>5. Formulation of missing standards as envisaged under Section 6 (1) (g) of the Act and development of general standards of discharge of environmental pollutants/effluents (Based on load, concentration, equipment)</li> <li>6. Coordinate and consult with relevant stakeholders on the framework and derived standards;</li> <li>7. Arranging workshops/Seminars in phases for input of stakeholders on draft PEQS, the consultant will conduct at least three workshops/seminars.</li> </ol> <p>Detailed Terms of References is at <b>Annex – II</b>.</p> <p><b><u>Scope of Consultancy - B:</u></b></p> <p>Categorization of industrial sectors on the basis of environmental impact and formulation of industry specific Punjab Environmental Quality Standards (EQSs). Consulting firm shall also propose guide-lines for sampling and sample processing methodology for each industry.</p> <p>The consultant will perform following tasks to achieve stated objective:</p>
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		<ol style="list-style-type: none"> <li>1. Categorization of industrial sectors on the basis of impact on environment;</li> <li>2. Formulation of industry specific Environmental Quality Standards (EQSs) for sixteen industries for final approval from the Punjab Environmental Protection Council.</li> <li>3. Coordinate and consult with relevant stakeholders on the framework and derived standards;</li> <li>4. Arranging workshops/Seminars (at least three) in phases for input of stakeholders on draft EQS.</li> <li>5. Assist SPIU/EPD to present the proposed guide-lines / environment quality standards for the final approval from Punjab Environment Protection Council</li> </ol> <p>List of industries/sectors for formulation of industry specific EQSs in Phase I is based on their magnitude and associated environmental impacts is at <b>Annex – I</b>. Detailed Terms of References is at <b>Annex – IV</b>.</p>								
	<p><b>ii. Implementation period</b></p>	<p>This ADP scheme is reflected at G.S.No. 6926-U (LO 20000145) having title “Development of missing Environmental Quality Standards and revision of existing Standards” with an estimated cost of Rs. 50.000 Millions.</p> <p>The project has gestation period of two years i.e. from FY 2021-22 to FY 2022-23. During FY 2021-22, the codal formalities for hiring of Consulting Firms will be completed with the payment of mobilization charges/advance. Whereas, subsequent payments will be made as per the payment schedule in the terms of references at <b>Annex – II &amp; IV</b>. A tentative implementation plan for the activities of the project has been chalked out and is at <b>Annex – III &amp; V</b>.</p>								
	<p><b>iii. Year wise estimated cost</b></p>	<p>Year wise estimated cost of the project is as follows: -</p> <p style="text-align: right;">(Rs. In Million)</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th colspan="2" style="text-align: center;">Allocation for</th> <th rowspan="2" style="text-align: center;">Total cost</th> </tr> <tr> <th style="text-align: center;">FY 2021-22</th> <th style="text-align: center;">FY 2022-23</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">27.600</td> <td style="text-align: center;">43.800</td> <td style="text-align: center;">71.400</td> </tr> </tbody> </table> <p>General Abstract of Cost is at <b>Annexure-VI</b>.</p>	Allocation for		Total cost	FY 2021-22	FY 2022-23	27.600	43.800	71.400
Allocation for		Total cost								
FY 2021-22	FY 2022-23									
27.600	43.800	71.400								
	<p><b>iv. Manpower requirements</b></p>	<p>No additional man-power is required under this project. The project staff hired under the ADP Scheme having title of “Strengthening of Strategic Planning &amp; Implementation Unit”</p>								

		will perform the functions like preparation of RFP, Evaluation of proposals etc.
	<b>v. Financial plan</b>	General Abstract of Cost is at <b>Annexure-VI</b> and breakup of remuneration and other details are given at <b>Annex – VII</b> .
4	<b>Expected outcome of the survey/ feasibility study and details of projects likely to be submitted after the survey.</b>	The outcome of the project is revision and formulation of environmental quality standards for different types of industries to enable EPA Punjab to effectively monitor and enforce such standards for improved environmental governance and lead sustainable development of Pakistan.

**Prepared By:**

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Project Director (SPIU), EPD Punjab

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## Annex-I

### PRIORITY INDUSTRIES FOR FORMULATION OF INDUSTRY SPECIFIC EQSS FOR GASEOUS EMISSION AND EFFLUENT DISCHARGE

<b>Sr. No</b>	<b>Industries/Manufacturing Units</b>
1	Pulp and paper industry
2	Ceramic industry
3	Paint Industry
4	Pesticide Industry
5	Tanneries & Leather Industry
6	Brick Kiln Sector
7	Cement Plants and Cement plants with co-processing
8	Stone Crushing Unit
9	Thermal Power Plant
10	Ethanol / distilleries Industry
11	All Integrated textile units, units of Cotton / Woolen / Polyester, Units having Printing / Dyeing / Bleaching process or manufacturing and Garment units
12	Foundries and Smelting Industry
13	Pharmaceuticals Industry
14	Sugar Industry
15	Polymers and Plastics
16	Chemical Industry (Acid manufacturing)

**TERMS OF REFERENCES FOR HIRING OF CONSULTING SERVICES FOR  
ASSIGNMENT - A**

**1. BACKGROUND**

The Environmental Protection Agency (EPA), Punjab is a Regulatory body and performs its functions under the provisions of the Punjab Environmental Protection Act, 1997. The Agency is required to implement the provisions of the Act *ibid* for the protection, conservation, rehabilitation and improvement of the environment, for the prevention and control of pollution, and promotion of sustainable development. Section 11 (1) of the Act states that “**Prohibition of certain discharges or emissions.** (1) *Subject to the provisions of this Act and the rules and regulations made there under no person shall discharge or emit or allow the discharge or emission of any effluent or waste or air pollutant or noise in an amount, concentration or level which is in excess of the Punjab Environmental Quality Standards or, where applicable, the standards established under clause (g) of sub-section (1) of section 6.*”. Historically, Pakistan Environmental Protection Council approved the National Environmental Quality Standards (NEQS) and after the devolution of the subject of Environment and Ecology through 18<sup>th</sup> Amendment to the Constitution of Pakistan, 1973, Punjab Environmental Protection Agency has adopted the 6 categories of NEQS as Punjab Environmental Quality Standards (PEQS) and formulated one new category of environmental quality standards, hence forming total seven environmental quality standards so far.

**2. PURPOSE**

The purpose of this study under an ADP scheme titled, “ **Development of Missing Environmental Quality Standards and Revision of Existing Standards**” is revision/rationalization of existing environmental quality standards and formulation of missing environmental quality standards. The scope of work is highly legal and technical in nature requiring hiring services of a Consulting Firm/s. The main objectives of this project are:

- 1- Develop a framework for deriving environmental quality standards;
- 2- Review, rationalize, and revise existing Punjab Environmental Quality Standards (PEQS);
- 3- Formulation of missing Environmental Quality Standards (EQSs);
- 4- Review and revision of Environmental Sample Rules, 2001 (for sampling and sample processing methodology etc.);

- 5- Coordinate with and consult relevant stakeholders on the framework and derived standards;
- 6- Arranging workshops/Seminars (at least three) in phases for input of stakeholders on draft PEQS.

### **3. EXISTING PUNJAB ENVIRONMENTAL QUALITY STANDARDS (PEQS) WHICH NEED REVISION AND RATIONALIZATION**

The following environmental quality standards will be reviewed, and updated, in the light of the framework developed under this project for deriving environmental quality standards:

- I. PEQs for industrial gaseous emissions
- II. PEQs Treatment of liquid and disposal of biomedical waste
- III. PEQs for Municipal and liquid Industrial Effluents: In comparison of pollution load regarding municipal and industrial effluents, parameter should be separated as the impact level is more intensive for industrial effluent. Therefore, permissible limits should be different for both.
- IV. PEQs for Noise
- V. PEQs for Ambient Air
- VI. PEQs for Motor Vehicle Exhaust and Noise
- VII. PEQs for Drinking Water

### **4. NEW ENVIRONMENTAL QUALITY STANDARDS WHICH REQUIRE TO BE MADE**

PEQs for Municipal and Industrial Liquid Effluents (32 parameters) and Industrial Gaseous Emissions (16 parameters) are uniform for all sectors of industry. Thus, environmental standards are same for Textile, Paper, Tanneries, Cement, Chemical, Fertilizer, Sugar, Distilleries, Electroplating, etc.

In addition to the review of existing PEQS, following environmental quality standards, rules, and guidelines are also needed in following areas:

1. Surface water bodies, as chemical pollution of surface water presents a threat to the aquatic environment with effects such as acute and chronic toxicity to aquatic organisms, accumulation in the ecosystem and losses of habitats and biodiversity, as well as a threat to human health. As a matter of priority, causes of pollution are to be identified and emissions should be dealt with at source, in the most economic and environmentally effective manner.
2. Environmental Quality Standards for Noise Emission & Vibration (for anthropogenic and Industrial sources)
3. Land/Soil Quality (Guidelines/standards)

4. Hazardous Waste generating from industries
5. Standards for reuse/recycling of treated liquid effluent and sludge for irrigation/horticulture purpose

Therefore, the existing PEQS shall be rationalized for their effective enforcement and facilitation of polluters in taking remedial measures for compliance through designing cost effective pollution control devices/systems/plants. While new standards in deficient areas shall be formulated.

### 3.0 SCOPE & COST OF THE CONSULTANCY:

#### 3.1 Scope:

The Consulting Firms has to perform the following activities as per following scope of project i.e.

Scope of Consulting firm-A	<ol style="list-style-type: none"> <li>1. Develop a framework for deriving environmental quality standards;</li> <li>2. Review, rationalize, and revise existing Punjab Environmental Quality Standards (PEQS);</li> <li>3. Develop general standards of discharge of pollutants/effluents (based on load, concentration and equipment)</li> <li>4. Review and revise Environmental Sample Rules, 2001</li> <li>5. Formulation of missing standards as envisaged under Section 6 (1) (g) of the Act and development of general standards of discharge of environmental pollutants/effluents (Based on load, concentration, equipment)</li> <li>6. Coordinate and consult with relevant stakeholders on the framework and derived standards;</li> <li>7. Arranging workshops/Seminars in phases for input of stakeholders on draft PEQS.</li> <li>8. Assist SPIU/EPD to present the proposed guide-lines / environment quality standards for the final approval from Punjab Environment Protection Council</li> </ol>
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#### 3.2 Cost:

Estimated cost of this consultancy is Rs. 20.800 Million. Breakup of remuneration and other details is given at **Annex – VI**.

#### 4.0 STAKEHOLDER CONSULTATIONS ETC.

The Consulting Firm shall arrange consultative workshops with stakeholder for taking their feedback/input.

#### 5.0 PROFESSIONAL LIABILITY OF CONSULTING FIRM

Professional liability as stated in the prevalent conduct and practice of consulting firms/Consulting Firms prescribed by PEC and as given under rule 54 of Punjab Procurement Rules, 2014 shall be applicable to the Consulting Firm.

#### 6.0 PAYMENT

The details of payment linked up with the activity and deliverables with timelines is as follows:-

#	Activity	Deliverable	Payment	Timeline
1.	The Consulting Firm shall prepare and submit an Inception Report within one month (30 days) after signing the agreement which shall include and explain the methodology & tools of work plan.	Inception report	10% payment on submission of inception report  10% payment on approval of inception report by Panel of Experts (list is attached at <b>Annex-VII</b> )	01 month after signing of agreement
2.	Submission of a Draft report including over view of existing Punjab Environmental Quality Standards (PEQs) and formulation of missing EQs in context of developing and developed countries at least two each.	Draft Report	30% payment on submission of report after incorporation of recommendations by Panel of Experts	3 months after approval of inception report.  2 months for review of draft report by SPIU and Panel of experts
3.	Sharing of reviewed report with different stakeholder and incorporating their comments	-	20% payment on submission of report after incorporating all necessary comments / updating in consultation with SP&IU	2 months after receiving Draft report incorporating recommendations of Panel of Experts
4.	Revision of report/standards (Final Draft for Approval by Punjab Environmental Protection Council		20% payment on acceptance of report by SP&IU/EPD	2 months after receiving review recommendations of Panel of Experts.

#	Activity	Deliverable	Payment	Timeline
5.	Approval from relevant forum	-	10 % after approval from the relevant forum	2 months

All payments made to the consulting firm are subject to sales tax and income tax deductions as per the governing laws.

#### 7.0 ROLE OF CLIENT

The client shall assist the Consulting Firm in obtaining information/data from other departments/organizations. Data from the field shall be collected by the Consulting Firm.

#### 8.0 DURATION

The consulting firm will be required to complete the whole activity/ assignment and furnish the final documents/ reports within a period of 12 months from the award of contract.

#### 9.0 CORE TEAM OF CONSULTANCY

#	Position	Qualification, Experience and Roles & Responsibilities	No. of Positions
i.	Team Leader	<p><b>Qualification:</b> Masters in Environmental Sciences/Engineering, Natural Resource Management, Climate Change, or any other field of Environmental Protection and/or Management, or any other field related to environment.</p> <p><b>Relevant Post Qualification Experience:</b> 05 years for PhD or 10 years for Masters</p> <p><b>Roles &amp; Responsibilities:</b></p> <ul style="list-style-type: none"> <li>❖ To oversee work of consulting firm and be responsible for all deliverables of the consultancy.</li> <li>❖ To supervise all project activities to derive environmental quality standards for the Province.</li> </ul>	1
ii.	Environmental Quality Standard Expert	<p><b>Qualification:</b> Masters in Environmental Sciences/Engineering, Natural Resource Management, Climate Change, or any other field of Environmental Protection and/or Management, or any other field related to environment.</p> <p><b>Relevant Post Qualification Experience:</b></p>	1



#	Position	Qualification, Experience and Roles & Responsibilities	No. of Positions
		<p>10 years of experience in the field of environment and preferably a part of similar exercise in any part of the world preferably in the developed or developing countries.</p> <p><b>Roles &amp; Responsibilities:</b></p> <ul style="list-style-type: none"> <li>❖ To review the existing environmental quality standards formulated in the context of the region as well as comparison with international best practice (s).</li> <li>❖ To broadly formulate new/revised environmental quality standards if required provided with justification.</li> </ul>	
iii.	Air Quality Expert	<p><b>Qualification:</b> Masters in relevant environmental/chemical/electrical Engineering or any other relevant field</p> <p><b>Relevant Post Qualification Experience:</b> 4 years for PhD or 7 years for MSc/Masters</p> <p><b>Roles &amp; Responsibilities:</b></p> <ul style="list-style-type: none"> <li>❖ In addition to reviewing the existing environmental quality standards formulated in the context of the region as well as comparison with international best practice (s).</li> <li>❖ To broadly formulate new/revised environmental quality standards if required provided with justification. Provide rationale for emission standards;</li> <li>❖ Preparation of mass-balance for the processes;</li> <li>❖ Derive environmental quality standards</li> </ul>	1
iv.	Wastewater Expert	<p><b>Qualification:</b> Masters in environmental/chemical/civil engineering or any other relevant field</p> <p><b>Relevant Post Qualification Experience:</b> 4 years for PhD or 07 years for MSc/Masters</p> <p><b>Roles &amp; Responsibilities:</b></p> <ul style="list-style-type: none"> <li>❖ Provide rationale for effluent standards;</li> <li>❖ Preparation of mass-balance for the processes;</li> <li>❖ Derive environmental quality standards</li> </ul>	1

#	Position	Qualification, Experience and Roles & Responsibilities	No. of Positions
v.	Environmental Economist	<p><b>Qualification:</b> Masters in environmental economics/development economics of any other field relevance</p> <p><b>Relevant Post Qualification Experience:</b> 04 years for PhD or 07 years for MSc</p> <p><b>Roles &amp; Responsibilities:</b></p> <ul style="list-style-type: none"> <li>❖ Economic analysis /considerations for revising the notified environmental quality standards; and</li> <li>❖ Economic analysis /considerations for adopting the proposed environmental quality standards.</li> </ul>	1
vi.	Health Expert	<p><b>Qualification:</b> MBBS or equivalent</p> <p><b>Relevant Post Qualification Experience:</b> 05 years' experience in the field of public health especially in the understanding and co-relating hazards of criteria pollutants on the health of the masses.</p> <p><b>Roles &amp; Responsibilities:</b></p> <ul style="list-style-type: none"> <li>❖ To provide the health hazards associated with the criteria pollutants</li> <li>❖ To assist in formulation/revision of environmental quality standards.</li> </ul>	1
vii.	Industrial Process Expert/Domain Expert	<p><b>Qualification:</b> M.Sc. in Chemical/Environmental/Industrial/Mechanical Engineering</p> <p><b>Relevant Post Qualification Experience:</b> 03 years work experience in the process industry or in related field</p> <p><b>Roles &amp; Responsibilities:</b></p> <ul style="list-style-type: none"> <li>❖ To provide the detailed study on industrial processes</li> <li>❖ To provide mass balances for each type of industry.</li> </ul>	1
viii.	Legal Expert	<p><b>Qualification:</b> LLM</p> <p><b>Relevant Post Qualification Experience:</b> 05 years work experience/practice in the field of environmental law.</p> <p><b>Roles &amp; Responsibilities:</b></p>	1

#	Position	Qualification, Experience and Roles & Responsibilities	No. of Positions
		<ul style="list-style-type: none"> <li>❖ To draft the proposed environmental quality standards in the legal format</li> <li>❖ To address the legal aspects related to such standards.</li> </ul>	

## 10.0 DELIVERABLES

Consulting firms will provide two hardcopies and softcopies (in Word and Portable Document Formats) of following reports:

### 10.1 INCEPTION REPORT

The consulting firms shall prepare and submit an Inception Report within one month of signing of the agreement which shall include and explain the methodology of work plan and time schedule for approval of SP&IU/ EPD.

### 10.2 REPORT REGARDING PUBLIC CONSULTATION/WORKSHOPS/SEMINARS ETC.

The consulting firms shall organize workshops/seminars with stakeholders as per requirement in consultation with SP&IU/ EPD and submit the report accordingly.

### 10.3 ENVIRONMENTAL QUALITY STANDARDS

The consultancy firm, hired under assignment – A, shall submit the review and proposed revised PEQs (if required) and suggest new / missing EQs, as mentioned above.

## 11.0 ELIGIBILITY CRITERIA

The consulting firm (s) securing at least 65 marks will be selected for this assignment.

The consulting firm(s) will be evaluated as per following eligibility criteria i.e.

#	Description	Maximum Marks
i.	Personnel for the project	60
ii.	Experience for undertaking the project related to the environment	40

**TENTATIVE TIMELINE OF ACTIVITIES / IMPLEMENTATION SCHEDULE FOR ASSIGNMENT (CONSULTANCY) - A**

	Activity	2021-22												2022-23											
		Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	April	May	June	
1.	Approval of PC-II and completing other codal formalities	■	■																						
2.	Advertisement Process as per PPRA Rules		■	■																					
3.	Pre-qualification of Consulting firms/Consultants				■	■																			
4.	Award of Contract						■	■																	
5.	Submission of Inception Report by consulting firm (s)								■																
6.	Submission of a Draft report including over view of industry in the context of Punjab, Environmental problems related to specific industry, Industry specific Environmental Quality Standards (EQSs)									■	■	■													

7.	Review of draft report by SPIU and Panel of Experts																																								
8.	Sharing of reviewed report with different stakeholder and incorporating their comments																																								
9.	Revision of report/standards (Final Draft for Approval by Punjab Environmental Protection Council)																																								
10.	Presenting final reports to PEPC and obtaining Approval after necessary revisions, if any																																								

**TERMS OF REFERENCES FOR HIRING OF CONSULTING SERVICES FOR  
ASSIGNMENT - B**

**5. BACKGROUND**

The Environmental Protection Agency (EPA), Punjab is a Regulatory body and performs its functions under the provisions of the Punjab Environmental Protection Act, 1997. The Agency is required to implement the provisions of the Act *ibid* for the protection, conservation, rehabilitation and improvement of the environment, for the prevention and control of pollution, and promotion of sustainable development. Section 11 (1) of the Act states that “**Prohibition of certain discharges or emissions.**– (1) *Subject to the provisions of this Act and the rules and regulations made there under no person shall discharge or emit or allow the discharge or emission of any effluent or waste or air pollutant or noise in an amount, concentration or level which is in excess of the Punjab Environmental Quality Standards or, where applicable, the standards established under clause (g) of sub-section (1) of section 6.*”. Historically, Pakistan Environmental Protection Council approved the National Environmental Quality Standards (NEQS) and after the devolution of the subject of Environment and Ecology through 18<sup>th</sup> Amendment to the Constitution of Pakistan, 1973, Punjab Environmental Protection Agency has adopted the 6 categories of NEQS as Punjab Environmental Quality Standards (PEQS) and formulated one new category of environmental quality standards, hence forming total seven environmental quality standards so far.

**6. PURPOSE**

The purpose of this study under an ADP scheme titled,” **Development of Missing Environmental Quality Standards and Revision of Existing Standards**” is formulation of new industry specific Punjab Environmental Quality Standards. The scope of work is highly legal and technical in nature requiring hiring services of a Consulting Firm/s. The main objectives of this project are:

- 1- Develop a framework for deriving environmental quality standards;
- 2- Formulation of industry specific environmental quality standards in terms of gaseous emission, effluent discharge, solid waste, Noise & Vibration etc.
- 3- Formulation of industry specific sampling methodology and techniques.
- 4- Coordinate with and consult relevant stakeholders on the framework and derived standards;

- 5- Arranging workshops/Seminars (at least three) in phases for input of stakeholders on draft EQSs.

### 3.0 SCOPE & COST OF THE CONSULTANCY:

#### 3.1 Scope:

The Consulting Firms has to perform the following activities as per following scope of project i.e.

Scope of Consulting firm - B	<p>Optimum and efficient internalization of environmental pollution costs requires industry specific environmental standards. The scope will include:</p> <ol style="list-style-type: none"> <li>1. Categorization of industrial sectors on the basis of impact on environment;</li> <li>2. Formulation of industry specific Environmental Quality Standards (EQSs) for sixteen industries (<b>Annex - I</b>) for final approval from the Punjab Environmental Protection Council.</li> <li>3. Coordinate and consult with relevant stakeholders on the framework and derived standards;</li> <li>4. Arranging workshops/Seminars in phases for input of stakeholders on draft EQSs, at least three.</li> <li>5. Assist SPIU/EPD to present the proposed guidelines / environment quality standards for the final approval from Punjab Environment Protection Council.</li> </ol>
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#### 3.2 Cost:

Estimated cost of this consultancy is Rs. 44.600 Million. Breakup of remuneration and other details is given at **Annex – VI**.

#### 4.0 STAKEHOLDER CONSULTATIONS ETC.

The Consulting Firm shall arrange consultative workshops with stakeholder for taking their feedback/input.

#### 5.0 PROFESSIONAL LIABILITY OF CONSULTING FIRM

Professional liability as stated in the prevalent conduct and practice of consulting firms/Consulting Firms prescribed by PEC and as given under rule 54 of Punjab Procurement Rules, 2014 shall be applicable to the Consulting Firm.

## 6.0 PAYMENT

The details of payment linked up with the activity and deliverables with timelines is as follows:-

#	Activity	Deliverable	Payment	Timeline
1.	The Consulting Firm shall prepare and submit an Inception Report within one month (30 days) after signing the agreement which shall include and explain the methodology & tools of work plan.	Inception report	10% payment on submission of inception report  10% payment on approval of inception report by Panel of Experts (list is attached at <b>Annex-VII</b> )	01 month after signing of agreement
2.	Submission of a Draft report including over view of industry in the context of Punjab, Environmental problems related to specific industry, Industry specific Environmental Quality Standards (EQSs) in context of developing and developed countries at least two each, review of existing PEQS related to specific industry, result & discussion based on field studies, magnitude of industry, process involves in that industry, techniques and environmental impact of each process, Industry specific best international practices related to address environmental problems, proposed EQSs and guidelines for pollution prevention.	Draft Report	30% payment on submission of report after incorporation of recommendations by Panel of Experts	3 months after approval of inception report.  2 months for review of draft report by SPIU and Panel of experts
3.	Sharing of reviewed report with different stakeholder and incorporating their comments	-	20% payment on submission of report after incorporating all necessary comments / updating in consultation with SP&IU	2 months after receiving Draft report incorporating recommendations of Panel of Experts



#	Activity	Deliverable	Payment	Timeline
4.	Revision of report/standards (Final Draft for Approval by Punjab Environmental Protection Council)		20% payment on acceptance of report by SP&IU/EPD	2 months after receiving review recommendations of Panel of Experts.
5.	Approval from relevant forum	-	10 % after approval from the relevant forum	2 months

All payments made to the consulting firm are subject to sales tax and income tax deductions as per the governing laws.

## 7.0 ROLE OF CLIENT

The client shall assist the Consulting Firm in obtaining information/data from other departments/organizations. Data from the field shall be collected by the Consulting Firm.

## 8.0 DURATION

The consulting firm will be required to complete the whole activity/ assignment and furnish the final documents/ reports within a period of 12 months from the award of contract.

## 9.0 CORE TEAM OF CONSULTANCY (EACH LOT)

#	Position	Qualification, Experience and Roles & Responsibilities	No. of Positions
ix.	Team Leader	<p><b>Qualification:</b> Masters in Environmental Sciences/Engineering, Natural Resource Management, Climate Change, or any other field of Environmental Protection and/or Management, or any other field related to environment.</p> <p><b>Relevant Post Qualification Experience:</b> 05 years for PhD or 10 years for Masters</p> <p><b>Roles &amp; Responsibilities:</b></p> <ul style="list-style-type: none"> <li>❖ To oversee work of consulting firm and be responsible for all deliverables of the consultancy.</li> <li>❖ To supervise all project activities to derive environmental quality standards for the Province.</li> </ul>	1
x.	Environmental Quality	<p><b>Qualification:</b> Masters in Environmental Sciences/Engineering, Natural Resource Management, Climate Change, or any other field</p>	1

#	Position	Qualification, Experience and Roles & Responsibilities	No. of Positions
	Standard Expert	<p>of Environmental Protection and/or Management, or any other field related to environment.</p> <p><b>Relevant Post Qualification Experience:</b> 10 years of experience in the field of environment and preferably a part of similar exercise in any part of the world preferably in the developed or developing countries.</p> <p><b>Roles &amp; Responsibilities:</b></p> <ul style="list-style-type: none"> <li>❖ To review the existing environmental quality standards formulated in the context of the region as well as comparison with international best practice (s).</li> <li>❖ To broadly formulate new/revised environmental quality standards if required provided with justification.</li> </ul>	
xi.	Air Quality Expert	<p><b>Qualification:</b> Masters in relevant environmental/chemical/electrical Engineering or any other relevant field</p> <p><b>Relevant Post Qualification Experience:</b> 4 years for PhD or 7 years for MSc/Masters</p> <p><b>Roles &amp; Responsibilities:</b></p> <ul style="list-style-type: none"> <li>❖ In addition to reviewing the existing environmental quality standards formulated in the context of the region as well as comparison with international best practice (s).</li> <li>❖ To broadly formulate new/revised environmental quality standards if required provided with justification. Provide rationale for emission standards;</li> <li>❖ Preparation of mass-balance for the processes;</li> <li>❖ Derive environmental quality standards</li> </ul>	1
xii.	Wastewater Expert	<p><b>Qualification:</b> Masters in environmental/chemical/civil engineering or any other relevant field</p> <p><b>Relevant Post Qualification Experience:</b> 4 years for PhD or 07 years for MSc/Masters</p> <p><b>Roles &amp; Responsibilities:</b></p>	1

#	Position	Qualification, Experience and Roles & Responsibilities	No. of Positions
		<ul style="list-style-type: none"> <li>❖ Provide rationale for effluent standards;</li> <li>❖ Preparation of mass-balance for the processes;</li> <li>❖ Derive environmental quality standards</li> </ul>	
xiii.	Environmental Economist	<p><b>Qualification:</b> Masters in environmental economics/development economics of any other field relevance</p> <p><b>Relevant Post Qualification Experience:</b> 04 years for PhD or 07 years for MSc</p> <p><b>Roles &amp; Responsibilities:</b></p> <ul style="list-style-type: none"> <li>❖ Economic analysis /considerations for revising the notified environmental quality standards; and</li> <li>❖ Economic analysis /considerations for adopting the proposed environmental quality standards.</li> </ul>	1
xiv.	Health Expert	<p><b>Qualification:</b> MBBS or equivalent</p> <p><b>Relevant Post Qualification Experience:</b> 05 years' experience in the field of public health especially in the understanding and co-relating hazards of criteria pollutants on the health of the masses.</p> <p><b>Roles &amp; Responsibilities:</b></p> <ul style="list-style-type: none"> <li>❖ To provide the health hazards associated with the criteria pollutants</li> <li>❖ To assist in formulation/revision of environmental quality standards.</li> </ul>	1
xv.	Industrial Process Expert/Domain Expert	<p><b>Qualification:</b> M.Sc. in Chemical/Environmental/Industrial/Mechanical Engineering</p> <p><b>Relevant Post Qualification Experience:</b> 03 years work experience in the process industry or in related field</p> <p><b>Roles &amp; Responsibilities:</b></p> <ul style="list-style-type: none"> <li>❖ To provide the detailed study on industrial processes</li> <li>❖ To provide mass balances for each type of industry.</li> </ul>	1
xvi.	Legal Expert	<p><b>Qualification:</b> LLM</p> <p><b>Relevant Post Qualification Experience:</b></p>	1

#	Position	Qualification, Experience and Roles & Responsibilities	No. of Positions
		05 years work experience/practice in the field of environmental law. <b>Roles &amp; Responsibilities:</b> <ul style="list-style-type: none"> <li>❖ To draft the proposed environmental quality standards in the legal format</li> <li>❖ To address the legal aspects related to such standards.</li> </ul>	

## 10.0 DELIVERABLES

Consulting firms will provide two hardcopies and softcopies (in Word and Portable Document Formats) of following reports:

### 10.1 INCEPTION REPORT

The consulting firms shall prepare and submit an Inception Report within one month of signing of the agreement which shall include and explain the methodology of work plan and time schedule for approval of SP&IU/ EPD.

### 10.2 REPORT REGARDING PUBLIC CONSULTATION/WORKSHOPS/SEMINARS ETC.

The consulting firms shall organize workshops/seminars with stakeholders as per requirement in consultation with SP&IU/ EPD and submit the report accordingly.

### 10.3 ENVIRONMENTAL QUALITY STANDARDS

The consultancy firm hired under scope-A and scope-B shall submit the package of Environmental Quality Standards as described in 3.1 of these terms of references. In addition to these the consultancy-B shall submit the following for each process/industry:

- i) Process description with mass balance
- ii) Details of Criteria pollutants/parameters for each industry along with their measurement methods
- iii) Propose guidelines for sampling and sample processing for sixteen industries.
- iv) Rationale/Justification for proposed environmental quality standards with economic analysis

## 12.0 ELIGIBILITY CRITERIA

The consulting firm (s) securing at least 65 marks will be selected for this assignment.

The consulting firm(s) will be evaluated as per following eligibility criteria i.e.

#	Description	Maximum Marks
ii.	Personnel for the project	60
v.	Experience for undertaking the project related to the environment	40

**TENTATIVE TIMELINE OF ACTIVITIES / IMPLEMENTATION SCHEDULE**

	Activity	2021-22												2022-23											
		Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	April	May	June	
11.	Approval of PC-II and completing other codal formalities	■	■																						
12.	Advertisement Process as per PPRA Rules		■	■																					
13.	Pre-qualification of Consulting firms/Consultants				■	■																			
14.	Award of Contract						■	■																	
15.	Submission of Inception Report by consulting firm (s)								■																
16.	Submission of a Draft report including overview of industry in the context of Punjab, Environmental problems related to specific industry, Industry specific Environmental Quality Standards (EQSs)									■	■	■													

17.	Review of draft report by SPIU and Panel of Experts																										
18.	Sharing of reviewed report with different stakeholder and incorporating their comments																										
19.	Revision of report/standards (Final Draft for Approval by Punjab Environmental Protection Council																										
20.	Presenting final reports to PEPC and obtaining Approval after necessary revisions, if any																										

**GENERAL ABSTRACT OF COST**

2021-22 to 2022-23

*(Rs. In Millions)*

<b>Head of Account</b>	<b>Description</b>	<b>Allocation for</b>		<b>Total cost</b>
		<b>FY 2021-2022</b>	<b>FY 2022-23</b>	
A03770	Consultancy Services	25	40.4	65.4
A03919	Payment to other services rendered	1	1	2
A03907	Advertisement & Publicity	0.2	0.3	0.5
A03903	Consultative Workshops	1	1.5	2.5
A03901	Stationery	0.1	0.1	0.2
A03902	Printing & Publication	0.1	0.2	0.3
A03970	Others	0.2	0.3	0.5
<b>Total</b>		<b>27.6</b>	<b>43.8</b>	<b>71.4</b>



**COST ESTIMATES FOR CONSULTANCY SERVICES**

<b>Consultancy Services for Assignment - A</b>					
<b>Review of existing &amp; Formulation of Missing Environmental Quality Standards (EQSs)</b>					
Sr. No	Description	Man Month	No. of Posts	Cost/Man Month	Cost (PKR)
<b>Part-A1 (Remuneration/Salary etc.)</b>					
1	Team Leader	6	1	500,000	3,000,000
2	Environmental Quality Standard Expert	6	1	450,000	2,700,000
3	Air Quality Expert	4	1	350,000	1,400,000
4	Wastewater Treatment Expert	4	1	350,000	1,400,000
5	Environmental Economist	4	1	350,000	1,400,000
6	Health Expert	3	1	350,000	1,050,000
7	Industrial Process Expert	4	1	350,000	1,400,000
8	Legal Expert	3	1	350,000	1,050,000
	<b>Sub-Total</b>				<b>13,400,000</b>
<b>Part-A2 (Operating Expenditures)</b>					
1	Field Surveys	6	1	150,000	900,000
2	Transportation (Driver + POL)	6	2	125,000	1,500,000
4	Advertisement & Publicity				500,000
5	Laboratory Tests, Health Analysis etc.				4,000,000
6	Stationery, Printing & Publication				500,000
	<b>Sub-Total</b>				<b>7,400,000</b>
<b>Total Cost of Consultancy - A</b>					<b>20,800,000</b>

<b>Consultancy Services for Assignment - B Formulation of Industry Specific Environment Quality Standards (EQSs)</b>					
<b>Sr. No</b>	<b>Description</b>	<b>Man Month</b>	<b>No. of Posts</b>	<b>Cost/Man Month</b>	<b>Cost (PKR)</b>
<b>Part-B1 (Remuneration/Salary etc.)</b>					
1	Team Leader	12	1	500,000	6,000,000
2	Environmental Quality Standard Expert	12	1	450,000	5,400,000
3	Air Quality Expert	8	1	350,000	2,800,000
4	Wastewater Treatment Expert	8	1	350,000	2,800,000
5	Environmental Economist	8	1	350,000	2,800,000
6	Health Expert	6	1	350,000	2,100,000
7	Industrial Process Expert	8	1	350,000	2,800,000
8	Legal Expert	6	1	350,000	2,100,000
	<b>Sub-Total</b>				<b>26,800,000</b>
<b>Part-B2 (Operating Expenditures)</b>					
1	Field Surveys	12	1	150,000	1,800,000
2	Transportation (Driver + POL)	12	4	125,000	6,000,000
4	Advertisement & Publicity				500,000
5	Laboratory Tests, Health Analysis etc.				8,000,000
6	Stationery, Printing & Publication				1,500,000
	<b>Sub-Total</b>				<b>17,800,000</b>
<b>Total Cost of Consultancy - B</b>					<b>44,600,000</b>

<b>Part-C (Operating Expenditure of SPIU)</b>					
1	Advertisement & Publicity			500,000	500,000
2	Honorarium Cost			2,000,000	2,000,000
3	Consultative Workshops			2,500,000	2,500,000
4	Stationery			200,000	200,000
4	Printing & Publication			300,000	300,000
5	Contingency			500,000	500,000
	<b>Sub-Total</b>				<b>6,000,000</b>
<b>Grand Total (Cost of Consultancy A + Cost of Consultancy B +C) (PKR)</b>					<b>71,400,000</b>

**Note:** The cost estimates given above are tentative in nature and consultancy firm may amend the allocation based on the actual implementation of the project. For example the cost allocated for testing may vary based on the scientific requirement, however the total amount of consultancy shall remain the same.

**PANELS OF EXPERTS**

An expert panel consists of experts from whom technical guidance and support will be taken to confirm the soundness of the reports/recommendations/EQS. The Panel includes:

- |   |   |               |
|---|---|---------------|
| 1 | Project Director, SP&IU <sup>1</sup>  | (Chairperson) |
| 2 | Representative from Academia<br>(University of the Punjab, FC College, G.C University, UET,LUMS etc.) | (Member)      |
| 3 | Representative from SUPARCO <sup>2</sup>  | (Member)      |
| 4 | Representative from PCSIR <sup>3</sup>  | (Member)      |
| 5 | Representative from PCRWR <sup>4</sup>  | (Member)      |
| 6 | Special Invitee (as needed)   | (Member)      |
| 7 | Director (EP & P), SP&IU  | (Secretary)   |

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<sup>1</sup> Strategic Program and Implementing Unit

<sup>2</sup> Pakistan Space and Upper Atmosphere Research Commission

<sup>3</sup> Pakistan Council of Scientific and Industrial Research

<sup>4</sup> Pakistan Council of Research in Water Resources