
Tamil Nadu Irrigated Agriculture Modernization Project - II (TN IAMP)

TERMS OF REFERENCE

Third Party Technical Examination of Works

Background:

The Irrigated Agriculture Modernization Project II (TN IAMP) seeks to support the effective development and management of Irrigated agriculture in the state of Tamil Nadu across line departments involved with irrigated agriculture.

The TN IAMP development objective is to enhance productivity and climate resilience of irrigated agriculture, improve water management and increase value-addition for farmers and agro entrepreneurs in selected sub-basin areas of Tamil Nadu. In addition to state-wide institutional strengthening for improved water resources management and irrigation service delivery, 66 sub-basin group in 13 basin groups in Tamil Nadu have been targeted for physical intervention. The Project will be implemented over a period of **seven years**.

About 70% of the project expenditure will be implemented by the Water Resources Department, and the remainder by the Government of Tamil Nadu's Agriculture Engineering Department, Agriculture Department, Horticulture Department, Tamil Nadu Agriculture University, Agriculture Marketing Department, Animal Husbandry Department and Fisheries Department, with management support and co-ordination provided by the Multi-Disciplinary Project Unit (or MDPU which has representation in all the disciplines that are part of this innovative project and in procurement and financial management aspects). Water resources planning and management will be carried out by the State Water Resources Management Agency or SWaRMA and Basin development and Management Boards. Sub-basin plans will be developed with effective consultative (involving farmers, WUAs, where set up, and other stakeholders) and technical input from the respective departments. These plans are expected to provide a shared vision for preparation and implementation of investments in each sub basin.

Type of Civil Works involved in sub-basins

Modernization of tanks and anicuts and improving supply channels, construction of artificial recharge well structures, rehabilitation of dilapidated structures, strengthening the tank bunds, repair/renewal of sluices or shutters, desilting, dewelding, etc.

Consultancy Objective:

The proposed consultancy is expected to assist the Government of Tamil Nadu in ensuring effectively quality management in the physical works to be undertaken as part of the project. In particular, the proposed Consultancy Services would:

- (i) Assess and update the current quality management system and develop new techniques for improved quality management (e.g. Manuals, OK Cards, formats as per technical and environmental specifications) of physical investments under the TNIAMP
- (ii) *Undertake quality management checking and reporting* (including improvement of an online quality information system) for these investments for a period of 7 Years, and,
- (iii) Train TN IAMP staff on effective quality management aspects

Scope of Work:

The physical works to be monitored are distributed in 66 sub-basins in the state of Tamil Nadu. These primarily pertain to the rehabilitation and modernization of tanks, canals, and drainage systems in 5.43 lakh ha of irrigated agricultural command.

The period of the proposed assignment shall be 7 Years from the date of the effectiveness of the contract.

Work shall be carried out through contractors after inviting bids as per World Bank's norms by the Respective Regional Chief Engineers, Superintending Engineers or Executive Engineers in-charge of the project works. The Construction supervision shall be taken by the implementing agencies with officers (including senior officers) of TN WRD and MDPU also inspecting the works as and when required. However, advisory services on quality assurance and contract management would be provided by the Independent Third Party Technical Examination of Civil Works consultants who would provide independent quality checking.

The Scope of Consulting Services include:

- Quality management on all key aspects of civil works (including aspects of engineering, construction supervision, quality of materials and works, related environmental and social aspects, etc.)
- Establishing quality standards and development of manuals/guidelines through training for quality management and maintenance.
- Technical adequacy of construction material quality/mix, storage, handling, use; and review of test results/certificates of such material
- Adequacy of safety measures related to construction.
- Safe disposal of earth, debris, weeds, etc in line with the environmental safeguards prescribed.
- Turfing of embankments and other relevant areas for erosion protection.
- MOUs are signed with WUAs as required.
- Acceptable quarry and borrow area identification and rehabilitation.
- Technically sound layout and construction as per approved designs, drawings, technical specifications and other stipulations contained in the Contract Documents Accountability of quality supervision.
- Whenever, substandard works is observed by the consultant and/or construction materials not confirming to the "acceptance quality test criteria" are observed to be used in the works, the consultant shall mostly promptly, within 24 hours, by either e-mail/Fax (followed by a detailed letter) bring such situations to the notice of the engineer in charge and the Regional Chief Engineer. He shall also immediately inform the contractor and the site department engineer recommending to stop using such materials and entry to this effect shall be made by him in the site instructions register. Based on this action of the consultant the Engineer in charge/Regional Chief Engineer shall take the decision on resuming the work after requisite remedial measures are taken by the contractor to the satisfaction of the Engineer-in-Charge / Regional Chief Engineer".
- Updating and improving the Manuals already available and Preparation of development of forms and OK cards for quality control and convey his opinion on progress & completion to the Regional Chief Engineer.
- Ensuring compliance with associated environmental and social mitigation measures as indicated in the Environmental and Social Assessment Framework for the TN IAMP.

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- Ensuring proper rehabilitation of the construction site in general and the Borrow areas in particular in compliance of the prescribed environmental safeguards.
 - The quality management would need to be done at various stages – pre-construction, during construction and post-construction, as described below:

During construction stage:

- Supervision at site to maintain quality checks through a system for hard and soft copies
- Monitoring progress of the quality of construction and material
- Keeping proper records of quality through reports, Ok Card system, written records and video/photos
- Maintaining close rapport and coordination with the M&E consultant to be employed by the MDPU for rendering a mutually synchronizing findings

After construction stage:

- The consultant shall furnish his written opinion on the completion of works which may be attached to the completion report.
- Deriving data for future use rates of items, overheads, mobilization, conclusions and derivation of constants for future reference
- Preparation & recommendations to accept completion drawings and completion reports of Project.

Key Tasks:

Task 1: Project Activity Familiarization

The Consultant will:

- Review project documents, including Project Appraisal Document (PAD) , Project Implementation Plan (PIP) AND Environmental and Social Assessment Framework.
- Review existing WRD, PWD, IS (Indian Standards), etc. guidelines, manuals, procedures, processes, ‘including USBR Manual’ ,
- Visit field locations for TN IAMP activities
- Review contract documents concluded with WUAs as and when concluded for each package.
- Discuss with MDPU, WRD, and other Line Department staff on TN IAMP activities

Task 2: Develop Methods for Improved Quality Management of TN IAMP Investments

The Consultant will:

- Develop sampling /testing protocols /procedures for quality management of each type of investment proposed under TN IAMP
- Establish specifications /standards for key activity types in accordance with Indian Standards.
- Develop specifications for modern equipment necessary for quality management.

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- Develop and improve existing quality management reporting arrangements for each type of investment (including OK cards - check lists and signoffs by contractor, WRD and WUA to Promote quality and accountability at various stages – as have been used in many other World Bank Projects in India), computerized formats, report structures /frequency /information flow, statistical analysis and visualization, etc.,
 - Maintenance of web-based quality management software and updation of the software, if any, for password –protected access at the Office of The Engineer – In – Chief , WRD, Chennai-05 with a computer with internet connection (the software should be able to have all the quality management reporting information, analysis and visualization)-including associated installation, training , refinement, and support.
 - Updation and improving of Manuals, if any, for quality management and maintenance (including guidelines /formats /procedures for each type of investment) in consultation with WRD and building upon existing standards and procedures. These should including descriptive material, standards / specifications, DOs and DON'Ts, video footage, etc.

Task 3: Check and Report on Quality of TN IAMP Investments for a period of seven years

The Consultant will:

- Maintain **three** mobile and **two** ground laboratory facilities as per the equipment list provided at the end of this ToR.
- Use the sampling / testing protocols / procedures (including use of modern testing equipment and non-destructive tests) for quality management of civil works under TN IAMP using well-structured Sampling, the consultant shall conduct at least 25% of the specified quality control tests independently for respective items of works in each package.
- The consultant shall verify at least 10 % of the tests being conducted by the contractor to ensure their accuracy and correct procedures.
 - Quality testing of materials
 - Contractor capacity and on-site quality management – equipment, plant, machinery, installations, adequacy of contractor quality management and testing, personnel on-site – as well as labour welfare, safety of works, personnel and general public, and housekeeping on-site.
 - Quality management of borrow areas and debris/silt disposal, erosion-control and turfing.
 - Confirmation of MOUs and land acquisition if any
 - Conformity to drawings, technical specifications ,workmanship, and construction contract stipulations on quality and applicable WRD and IS codes applicable for each item of work.
 - Conformity with expected works implementation schedule as per agreed conditions of contract for each package.
 - Compliance of Environment Management Plan as well as safety of works, personnel and the general public.
 - Checking the OK Card system implementation.

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- Observations for follow-up, highlighting critical actions that need to be addressed immediately
 - Verification of compliance in addressing observations in earlier visits. The Consultant may also be required to perform repeat tests, as required by the Executive Engineer, WRD. These repeat tests or measurements may be conducted in the presence of Executive Engineer, WRD or his representatives on his request.
- Fill reporting formats Also take photographs and video footage of structures, cement concrete lining in canals, mechanical fixtures, hoisting arrangement, mechanized compaction of earth fill on tank bunds with vibratory rollers and of any other associated work / structure directed by the Engineer –in Charge.
 - Develop and host secure web-based quality management portal to enable quick access to quality management information (manuals, procedures , quality testing schedules, formats, photos/videos, OK cards) and track follow-up.
 - Uploading of the quality data (including data, photographs, field notes, etc.) on a weekly basis to the web-based quality management software to facilitate quality management and contractor payment and to enable linkage with the Geo-tagging mechanism proposed in the Project for monitoring the progress.
 - Provide credible, regular reports (with effective layout and appropriate data, photos, good graphics, etc.) on status of quality management under TN IAMP and suggested remedial measures to improve quality of civil works mechanical fixtures, gates, shutters, hoisting arrangement under TN IAMP and issues for WRD/MDPU attention. Also suggest implications for modifications in procurement contracts for future activities.

Task 3: Training Staff on Quality Management

The Consultant will:

- Undertake On-the-Job training for WRD and MDPU staff for quality management under the TN IAMP
- Hold workshops (with field demonstrations) for training on quality management (twice a year for about **50** participants at each workshop) – with appropriate developed training materials, handouts, CDs, etc.
- On-call/as-required advice to WRD on quality management during the duration of the consultancy
- Suggest measures for WRD to improve quality management, including changes in procedures, manuals, training, and modernization of quality management equipment

CLIENT SUPPORT:

- Engineer in Chief, WRD / Regional Chief Engineer / Superintending Engineers and the Executive Engineers of each division, WRD and Executive Engineer Designs nominated by Superintending Engineer Designs in his office shall be the counterpart for the consulting team in tasks related to Irrigation and drainage.

- The Engineering and other staff of the designated divisions will work closely with the consultant's team in a true spirit. This will facilitate technology transfer to the client.
- The client will provide details and maps / GIS datasets of all the proposed construction works of the irrigation and drainage infrastructure in the project area, if available. The client will also make available hydraulic particulars of canal and drains, details of structures such as location of various control structures on the conveyance system along with the number of gates, type of gates, size etc. and details of other works. The client will provide any other data as available and as found necessary by the consultants or extend help in its procurement from other government sources to enable the consultants to perform the tasks. Collection of data and information from client shall be the sole responsibility of the consultant. The Client will provide space (not necessarily with building) free of cost on a temporary basis to accommodate Consultant equipment during testing.
- The client will make available the programme for physical works to be executed during the following month in advance.
- The client will make available copies of the implementation / procurement schedule, plans, estimates and detailed engineering designs of individual package prepared and as and when submitted by the design consultant etc. and Contract agreement for inspection.
- The client will ensure that during the period of consultancy, the consultant shall have the access to the field and **regional laboratories** and to all records maintained at the work sites connected with quality control test and of previous inspections by other supervisory officers.
- Any other facilities mutually agreed upon by consultant and Client.

DELIVERABLES:

Deliverable	Description	Reporting (including interactive presentation of all deliverables at MDPU)	Timing (after signing contract)
Inception Report	<ul style="list-style-type: none"> ▪ Methodology ▪ Detailed work plan ▪ Detailed staff deployment plan ▪ Training Schedule 	Draft: 10 copies (with 10 CDs) Final: 50 colour copies (with 50 CDs)	2 Months
Initial Establishment of Quality Control Field Laboratories (For First Batch)	<ul style="list-style-type: none"> ▪ Establishment of two Ground and three Mobile quality control Laboratories including the possible utilization of the Mobile Testing Labs in SM&R Division WRD / Quality Control Division, Chennai-5 / Quality Control Division, Madurai (In addition to the new three mobile labs) ▪ Deployment of all field personnel 	Report on Status (10 Copies with 10 CDs)	1 Month before next construction season begins.
Report on the uploading of results in the Web-based Quality Management	<ul style="list-style-type: none"> ▪ Weekly data uploading. ▪ Improvements to the software, if any 	Draft:10 copies (with 10 CDs) Final: 50 color copies (with 50	Every year

Deliverable	Description	Reporting (including interactive presentation of all deliverables at MDPU)	Timing (after signing contract)
Software already developed and which is in use.		CDs)	
Monthly Reports	<ul style="list-style-type: none"> • Submission of monthly reports showing the number of tests conducted respectively on : materials , soils, compaction, cement, concrete, water, cement concrete lining, stones (revetment), aggregates etc . 	Draft:10 copies (with 10 CDs)	Every month
Quarterly Reports	<ul style="list-style-type: none"> ▪ Reporting by scheme, package, sub-basin and basin ▪ Lessons from completed packages in that quarter ▪ Issues flagged for next quarter ▪ Effective uploading and serving of web-based Quality Management Software. 	Presentation of report at MDPU Draft:10 copies (with 10 CDs) Final: 50 color copies (with 50 CDs)	Every 3 months for 7 years.
Annual Reports	<ul style="list-style-type: none"> ▪ Reporting by scheme, package, sub-basin and basin ▪ Lessons from completed packages in that year. ▪ Issues flagged for upcoming year. 	Draft:10 copies (with 5 CDs) Final: 50 color copies (with 50 CDs)	Every year for 7 years.
Training	<ul style="list-style-type: none"> ▪ 2 workshops (with 50 participants per workshop) per year for 7 years. ▪ On – the – Job training ▪ Training materials Developments ▪ As- required advise on quality management. 	50 color copies (with 100 CDs) per Workshop.	As Specified.
Completion Report	<ul style="list-style-type: none"> ▪ Compilation of all activities carried out by Consultant ▪ Lessons learned ▪ Suggestions to improve quality management at TNWRD in future 	Draft: 10 copies (with 5 CDs) Final: 100 color copies (with 200 CDs)	At the end of 7 Years

COMPOSITION OF REVIEW AND APPROVAL COMMITTEES AND REVIEW PROCEDURE:

- A. To ensure conduct of consultancy, assignment Regional Level Review Committee (WRD) for providing necessary advice and mid course corrections would be constituted as under: -

S. No.	Designation of Officer	Position
1	Regional Chief Engineer	Chairman
2	Superintending Engineer.	Member
3	Concerned Field Executive Engineer	Member Secretary

- (a) The firm / consultant is expected to examine, review provision, work plans, intermediate status report etc. The work plan shall be submitted to the E-in-C's office for discussion / inter-action and approval with feedback from MDPU by the Consultant.
- (b) Monthly and Quarterly report shall be submitted to Regional Chief Engineers, Chief Engineer, Plan Formulation, Superintending Engineer Designs with copies to E-in-C and MDPU
- (c) After completion of the work of scheme / package, submit completion report to E-in-C's office., CEs Concerned and MDPU.
- (d) All the deliverables of the consultancy work of the schemes in a particular sub basin shall be submitted to the respective EE office.

The consultant shall keep the Chief Engineer, Plan Formulation, and Superintending Engineer Designs informed of their progress through monthly progress reports with copy to EIC. The consultant will interact with the committee at regular intervals as required by the Chairman of Review Committee.

- B. There would be an Approval Committee at the Office of E-in-C WRD level as under: -

S. No.	Designation of Officer	Position
1	Engineer-in Chief WRD	Chairman
2	Concerned field Chief Engineer, WRD	Member
3	CE, Plan Formulation, WRD	Member
4	CE, DRCS, WRD	Member
5	Procurement Superintending Engineer, WRD,PWD in EIC office Cell	Member
6	Superintending Engineer, Designs circle, WRD	Member Secretary

The Inception report and Final Report shall be submitted directly to the Approval Committee. All other reports and Draft Final Report shall be submitted to the Approval Committee through Basin level Review Committee (WRD) for approval.

List of Key Professionals whose CVs (Curriculum Vitas) and Experiences would be evaluated is as follows:

Sl. No	Key Professionals	Description of Services provided	Experiences	Number of Persons
1	Team Leader (One Civil Engineer) Minimum Qualification Post Graduate in Engineering	Overall coordination, team leadership, reporting, liasoning with Client to fulfil the ToR.	> 20 years demonstrated experience of Modern Construction Technique, familiarity with Irrigation Projects related construction works. Experience in Water Use Management with core experience in small canal irrigation system and drainage sector reforms. S/He should have atleast 10 years experience of Technical Checking and Quality control of works, assignment.	1
2	Basin Quality Management Engineer (Civil Engineer) Minimum Qualification Bachelor in Engineering with Masters in Business Administration	Overall coordination of consultant staff at Basin level; Interaction with Regional CES and Field Engineers	> 15 years demonstrated experience in the Project Management of Modern Construction Technique, familiarity with Irrigation Projects related with construction works. S/he should atleast 5 years experience of technical Checking and Quality Control of works, assignment.	2
3	Environment and Social Specialists Minimum Qualification Post Graduate in Environmental Studies, Social Development Specialist	Environmental and Social aspects of quality management	> 15 years demonstrated experience with environmental/ Social assessments related to water resources and Irrigation projects.	2(1+1)
4	Quality Management Engineer Minimum Qualification (Bachelor in Engineering / Civil)	Field – level quality management and reporting	> 10 years demonstrated experience in the Project Management of Modern Construction Technique, familiarity with Irrigation Projects related with construction works. S/he should atleast 3 years experience of technical Checking and Quality Control assignment. Expertise in construction Material testing is necessitate.	4
5.	Training Specialist Minimum Qualification (Masters in Business Administrative)	Planning, coordination and execution of workshops, preparation of training materials	> 15 years experience in planning of irrigation and drainage related trainings, particularly in modern construction technique along with quality control testing.	1
6.	IT Expert (For uploading of results in the Web-based Quality Management Software) Minimum Qualification (Masters in computer Application / Master of Science in Computers (MSc) Administrative	Overall Design and development of the web based quality management system. soft ware	> 5 years experience of Monitoring Information System and Decision Making process in Water Sector.	1
			Total	11

Further it is required that the consultancy should have subordinate technical staff such as Diploma Engineers Civil/Mechanical supervisor field Engineers, lab Assistants/Scientists, data entry operator programmers and other clerical support staff.

The consultants shall give details in the Technical Proposal and its costs shall be included in the Financial Proposal including all facilities, equipment(Engineering, Testing lab with equipments and office), transport, computer hardware and peripherals, computers software, communication system (telephone, fax, e-mail / internet) and support staff which they consider to carry out the service. The space for testing lab will be provided by Executive Engineer, WRD and completion of work all equipment procured under this assignment and paid for by the client will be the asset of Executive Engineer, WRD.

The consultant firm shall depute some Senior Engineer of Management level to visit each Scheme where his team is working at least once two months and discuss the progress with the Executive Engineer, WRD in charge of work. The details of such discussions shall be kept on record.

Establishment of Office:-

Consultant will establish a full fledged office at Chennai with link with EIC office, all infrastructure and office establishment etc., where the Team leader along with his staff will be stationed. Further it is required that the consultant should have subordinate technical staff such as Civil/Mechanical supervisor field Engineers, lab Assistants/Scientists, data entry operator programmers and other clerical support staff.

Annexure –A I
Minimum required equipments in Ground Laboratory

<u>SL. No.</u>	<u>Name of the equipment</u>	<u>Quantity</u>
<u>I.</u>	<u>Building Materials including Cement, Mortar & Concrete</u>	
1.	Electronic Balance to weigh upto 5 kg with 0.1gm accuracy	1 No.
2.	Vicat Apparatus with Consistency, IST and FST Needles	1 set
3.	Cube Mould with Base plate – Size 70.6mm	9 Nos.
4.	Tamping Rod – 15cm long & 1 cm dia	1 No.
5.	Straight Edge (Steel) – 0.5m long	2 Nos.
6.	Vibrating Machine with timer (for Cement Mortar Cube)	1 No.
7.	Curing Tank (Covered)	1 No.
8.	Compression Testing Machine – 100 capacity	1 No.
9.	Le Chatelier Apparatus	3 sets
10.	Water Bath	1 No.
11.	Blaine Air Permeability Apparatus	1 No.
12.	Platform Balance – 100kg Capacity	1 No.
13.	Universal Testing Machine – 100 T Capacity	1 No.
14.	Electrically operated Drying Oven (Upto 225 °C)	1 No.
15.	Set of Std. Sieves 200mm Dia – sq. hole 4.75mm to 75 micron	1 set
16.	Sieve Shaker 200mm Dia	1 No.
17.	Pycnometer (Small)	3 Nos.

18.	Set of Std. Sieves 300mm Dia – sq. hole 80mm to 4.75 mm	1 set
19.	Pycnometer (Large)	3 Nos.
20.	Tamping Rod – 45 cm long & 1.5 cm dia	2 Nos.
21.	Laboratory Concrete Mixer	1 No.
22.	Slump Cone Apparatus	1 No.
23.	Compaction Factor Apparatus	1 No.
24.	Cube mould with Base Plate – Size 150 mm	1 set
25.	Needle Vibrator	1 No.
26.	Compression Testing Machine – 200 T Capacity	1 Nos.
27.	Concrete Core Drilling Machine	1 No.
28.	Thermometer	2 Nos.
29.	Glass bottle (350ml)	2 Nos.
30.	Other Accessories like Sample Trays (up to 600 x 600 x 75 mm) Measuring Jars (up to 1000cc), etc.	12 sets
31.	pH Meter	1 No.
32.	Electrical Conductivity Meter	1 No.
33.	Colorimeter	1 No.
34.	Glassware Items such as Burette (up to 50ml), Conical Flask (upto250ml), Measuring jar (up to 1000ml), etc.	6 sets.

Note 1. The above list of equipments is the minimum required for conducting routine and general quality control tests. In case any other special tests are required to be done, the Department shall direct the consultant to carry out the same from any recognized laboratory acceptable to Department the cost of such tests will be borne by the Consultant.

2. Besides the Mobile Labs indicated in Task 3 First bullet, the Consultant shall also engage the Mobile testing labs under the EE SM&R Division WRD / Quality Control Division, Chennai-5 / Quality Control Division, Madurai with an acceptable and agreed payment term for carrying out the tasks

3. After the completion of the Assignment Two Ground Lab with equipments and Three Mobile Lab with equipments and accessories shall be handed over to the respective quality control divisions as ordered by the SE Designs.

<u>II.</u>	<u>Soils</u>	
1.	Core Cutter Apparatus (for field density)	2 sets
2.	Sand Replacement Apparatus (for field density)	1 set
3.	Top pan Balance 1kg Capacity with 0.01 gm accuracy	1 No.
4.	Hydrometer	1 No.
5.	Electronic Digital Stop Watch	2 Nos.
6.	Liquid Limit Device	1 No.
7.	Cone Penetrometer	1 No.
8.	Standard Proctor Compaction Apparatus	2 sets
9.	Rapid Moisture Meter	1 No.
10.	Hot plate	1 No.
11.	Glass Plate (20cm square & 0.5cm thk)	2 Nos.
12.	Other Accessories like Sample Trays (15cm x 10 cm x 1 cm), etc.	12 sets
13.	Glassware Items such as Pipette (10 ml & 20 ml), Beaker (upto 500ml), etc.	6 sets

Annexure –A II
Minimum required equipments in a Mobile Laboratory

<u>S.No.</u>	<u>Name of the equipment</u>	<u>Quantity</u>
<u>I.</u>	<u>Building Materials including Cement, Mortar & Concrete</u>	
1.	Electronic Balance to weigh upto 5 kg with 0.1gm accuracy	1 No.
2.	Electrically operated Drying Oven (Upto 225° C)	1 No.
3.	Set of Std. Sieves 200mm Dia – sq. hole 4.75mm to 75 micron	1 set
4.	Sieve Shaker 200mm Dia	1 No.
5.	Pycnometer (Small)	3 Nos.
6.	Set of Std. Sieves 300mm Dia – sq. hole 80mm to 4.75 mm	1 set
7.	Pycnometer (Large)	3 Nos.
8.	Tamping Rod – 45 cm long & 1.5 cm dia	2 Nos.
9.	Slump Cone Apparatus	1 set
10.	Cube mould with Base Plate – Size 150 mm	6 Nos
11.	Needle Vibrator	1 No.
12.	Other Accessories like Sample Trays (upto 600 x 600 x 75 mm), etc.	6 sets
13.	Glass bottle (350ml)	2 Nos.
14.	Logging Cover Meter	1 No.
<u>II.</u>	<u>Soils</u>	
1.	Core Cutter Apparatus (for field density)	2 sets
2.	Top pan Balance 1kg Capacity with 0.01 gm accuracy	1 No.
3.	Rapid Moisture Meter	2 Nos.
4.	Glass Plate (20cm square & 0.5cm thk)	2 Nos.
5.	Other Accessories like Sample Trays (15cm x 10 cm x 1 cm), etc.	6 sets
6.	Measuring jars (upto 1000ml)	3 sets
7.	Non Nuclear Density Testing Device	1 No.

ANNEX B
List of 66 selected Sub Basins TN IAMP

SI.No	Basin	Sub Basin No	Sub Basin Name	Sub Basin Cumulative No
1	2	3	4	5
1	Chennai Basin	1	Gummudipoondi	1
		2	Nagariyar	2
		3	Nadhiyar	3
		4	Kovalam	4
2	Palar Basin	1	Upper Palar	5
		2	Malattar	6
		3	Agaramar	7
		4	Vegavathi	8
		5	Cheyyar	9
		6	Lower Palar	10
3	Pennaiyar Basin	1	Chinnar -1A	11
		2	Chinnar – 1B	12
		3	Pambar	13
		4	Vaniyar	14
		5	Matturar	15
		6	ValayarOdai	16
		7	Ramakkalodai	17
		8	Aliyr	18
		9	Muskundanadhi	19
		10	Krishnagiri to Pambar	20
		11	Lower Penaiyar	21
4	Vellar Basin	1	Manimukdhaadhi	22
		2	Lower Vellar	23
5	Paravanar Basin	1	Paravanar	24
		2	Uppanar	25
6	Cauvery Basin	1	Chinnar	26
		2	DoddaHalla	27
		3	Mettur Reservoir to Noyyal Confluece	28
		4	PalarTttHalla	29
		5	Moyar	30
		6	Upper Bhavai	31
		7	Lower Bhavai	32
		8	Noyyal	33
		9	Thirumaimuthar	34
		10	Karairottanar	35
		11	Coleroon)	36
		12	Ariyar	37
		13	Ponaniyar	38
		14	Nandiyar – Kulaiyar	39
		15	Marudaiyar	40
		16	Lower Coleroon	41
		17	Cauvery Delta	42

SI.No	Basin	Sub Basin No	Sub Basin Name	Sub Basin Cumulative No
1	2	3	4	5
7	Parambikulam Aliyar Project	1	Walayar	43
		2	Sholaiyar	44
8	Vaigai Basin	1	Suruliyar	45
		2	Varahanadhi	46
		3	Majalar	47
		4	Sirumalaiyar	48
		5	Sathaiyar	49
		6	Uppar	50
		7	Lower Vigai	51
9	Vaippar Basin	1	Kousiganadhi	52
10	Kallar Basin	1	Kallar	53
11	Tamiraparani Basin	1	Upper Tamiraparani	54
		2	Manimuthar	55
		3	Gadananadhi	56
		4	Pachaiyar	57
		5	Chittar	58
		6	Lower Tamiraparani	59
12	Nambiyar Basin	1	Nambiyar	60
13	Kodayar	1	Pechiparai	61
		2	Chittar (Kodayar)	62
		3	Perunchani	63
		4	Kuzhithuraiyar	64
		5	Valliyar	65
		6	Pazhayar	66

Annexure - III**Frequency of Testing**

Sl. No.	Test	Frequency of Test	Purpose of test	Reference
General Investigation				
1	Trial Pits and borings	3 boreholes or trial pits for 0.4 hectare area	To explore the subsoil surface thoroughly	IS 1892 - 1979
Investigation for Earth and Rockfill dams				
2	Trial Pits	For dams less than 30m height, exploration by pits at a spacing of 250m to 300m depending upon the nature of material may be necessary	To explore the subsoil surface thoroughly	IS 6955-2008
3	Boreholes	For dams less than 30m height, holes should be suitably staggered to provide information at 30m intervals. The depth of $\frac{1}{3}$ of these holes may be kept equal to the hydraulic head of the dam.	To explore the subsoil surface	IS 6955-2008
4	Depth of exploration	It may be sufficient to explore up to a depth of $\frac{1}{2}$ or $\frac{1}{3}$ of the hydraulic head at the location of the dam if rock is found at shallow depths. If the depth to rock is larger than $\frac{1}{3}$ or $\frac{1}{2}$ the hydraulic head, one or two drill holes may be taken to 10m into the in-situ rock	To explore the subsoil surface	IS 6955-2008
Laboratory testing of soils				
5	Grain Size analysis for classification and Atterberg Limits	For Every 3000m ³	To identify the classifications of soil utilized in the formation of embankments	1. IS 2720 (Part 4)-1985 2. IS 2720 (Part 5)-1985

Sl. No.	Test	Frequency of Test	Purpose of test	Reference
6	Field Density and moisture content	one test for every 1500m ³ of earthwork and atleast one test in each layer laid on embankment	To determine the placement density and moisture content	1. IS 2720 (Part 28)-1974 2. IS 2720 (Part 29)-1975 3. IS 2720 (Part 33)-1971
7	Permeability test	one test for every 3m of embankment height or for 20,000m ³	To determine permeability characteristics of the fill material	IS 2720 (Part 17)-1986
8	Direct Shear test	one test for every 3m of embankment height or for 20,000m ³	To determine the shear characteristics of fill material	IS 2720 (Part 13)-1986
9	Unconfined compression test	one test for every 3m of embankment height or for 20,000m ³	To determine the Unconfined compression strength of clayey soils	IS 2720 (Part 10) 1973
10	Triaxial Shear test	one test for every 3m of embankment height or for 20,000m ³	To determine the shear characteristics of fill material (in-situ)	IS 2720 (Part 12) 1981
11	Consolidation test	one set of three samples in every 6m height of embankment or for 30,000m ³	To determine the settlement rate and its magnitude	IS 2720 (Part 15) 1986
12	Standard Proctor Test	For every 10,000m ³ of compacted earth or where there is change in the borrow area or change of soil texture, limited to minimum three samples and maximum 10 samples	To determine the maximum dry density (MDD) and optimum moisture content of the soil and compare the results with laboratory value	IS 2720 (Part 7)-1980
13	Free Swell Index	For Every 3000m ³	To determine the free swell index of the soil	IS 2720 (Part 40)-1977
14	Moisture content	One test in each sample	To determine the moisture content of the sample	IS 2720 (Part 2)-1973
15	Shrinkage Factor	One test in 5m of embankment height	To determine the shrinkage limit	IS 2720 (Part 6)-1972

Sl. No.	Test	Frequency of Test	Purpose of test	Reference
Determination of Cut off depth of Earthen bund				
16	Cut off depth of earthen bund	One test for every 100m interval long the center line of the bund	To determine the cut-off depth of earthen bund it is essential to carry out the field permeability test	
Filters				
17	Grain Size Analysis	One test for every 200m ³ of filter (sand) one test for every 200 m ³ of filter (Aggregate)	To determine the percentage of the D10, D15, D30, D50, D60 and D85 grain size of materials	IS 9429 - 1999
Chemical analysis on soil				
18	Determination of total soluble solids	One test in each location	to determine total soluble solids	IS 2720 (Part 21)-1977
19	Determination of organic matter	One test in each location	to determine the organic matter	IS 2720 (Part 22)-1972
20	Determination of Ph Value	One test in each location	to determine the pH Value	IS 2720 (Part 26)-1987
21	Determination of total soluble sulphates	One test in each location	to determine total soluble sulphates	IS 2720 (Part 27)-1977

Sl. No.	Test	Frequency of Test	Purpose of test	Reference
FINE AGGREGATE				
22	Sieve Analysis	One test for every 150 m ³ of sand used in Concrete	To know grain size and the fineness modulus of sand	IS 2386 Part-I 1963 IS 383-2016
23	Unit Weight and Bulkage of sand	-As above- (also once in a shift or for every consignment)	To utilize data for mix design computation	IS 2386 Part-III 1963
24	Organic Impurities	-As above-	To assess the quality of sand	IS 2386 Part-III 1963
25	Soundness	One test for every 150 cum of sand used in Concrete	To assess the quality of sand	IS 2386 Part-II 1963
26	Silt Content	One test for every 150 cum of sand used in Concrete	To assess the silt content present in the sand	IS 2386 1963
27	Specific Gravity, moisture content and absorption	One test for every 150 cum of sand used in Concrete	To utilize the data for mix design computations	IS 2386 Part III 1963
COARSE AGGREGATE				
28	Sieve Analysis	One test for every 150 m ³ or less	To know gradation and percentage of various size	IS 2386 Part-I 1963 IS 383-2016
29	Specific Gravity,	One test for every 150 m ³ or less	To utilize data for mix design computation	IS 2386 Part-III 1963
30	Bulk density,			
31	Moisture content, Absorption			
32	Silt Content			
33	Soundness test (Sodium Sulphate method)	One test for every 150 m ³ or less	To assess the quality of coarse aggregate	IS 2386 Part-V 1963 IS 383-2016

Sl. No.	Test	Frequency of Test	Purpose of test	Reference
Mechanical Properties				
34	Abrasion, Impact	One test for every 150 m ³ or less	To assess the quality of coarse aggregate	IS 2386 Part-IV 1963
35	Crushing value			
36	Impact Value			
37	Combined Fineness and Elongation modulus	One test for every 150 m ³ or less	To assess the quality of coarse aggregate	IS 2386 Part II 1963
38	Organic Impurities (Mica content)	One test for every 150 m ³ or less	To assess the quality of coarse aggregate	IS 2386 Part II 1963 IS 383-2016
39	Alkali reactivity (alkali- Aggregate reactivity)	Twice in one working season	To know the 'innocuous' or 'deleterious' nature of aggregate	IS 2386 Part VII 1963 IS 383-2016
40	Petrographic Examination	Twice in one working season	To know the deleterious constituents and silt in aggregate	IS 2386 Part - VIII 1963 IS 383-2016
RR STONE				
41	Crushing Strength	For each quarry	To find the suitability of stone for masonry work	1121 – 1974
42	Water Absorption			1124– 1974
43	Durability			1126– 1974
	REINFORCEMENT			
44	Weight	For each consignment	To find the quality of steel reinforcement bars to be used as structural steel	IS 1608 – 1972, IS 1786 – 2008, IS 432 – 1966
45	Diameter			
46	Ultimate Tensile strength Test			
47	0.2% proof stress or yield stress			
48	Elongation			

Sl. No.	Test	Frequency of Test	Purpose of test	Reference	
<u>CEMENT</u>					
b) <u>Physical properties</u>					
49	Fineness	For each consignment	To identify the suitability of cement for the purpose used	IS-4031-1988 IS 269-1989 IS 8112-1989 IS 12269-1987 IS 1489-1991 IS 12600-1989	
50	Soundness (Le Chatelier)				
51	Consistency				
52	Setting time				
	Initial (IST)				
	Final (FST)				
53	Compressive Strength				
	of Cm 1:3 at 3 days				
	7 days				
	28 days				
54	Drying Shrinkage				
55	Heat of Hydration				
	7 days				
	28 days				
56	Specific Gravity				
57	Compressive Strength for Concrete	Qty. (m3)	No.of Samples **	To find the strength of hardened concrete according to the grade of concrete desired [** 1Sample means average of 3 specimen (cubes)]	IS 516-1959 IS 456-2000
		1 to 5 m ³	1		
		6 to 15 m ³	2		
		16 to 30	3		
		31 to 50	4		
	50 & above	4 + one addl. for each 50 (m ³)			
58	Cube test for cement mortar in masonry	3 tests per each grade of mortar per day	To find the strength of cement mortar	IS 2250-1981 Appendix A	

Sl. No.	Test	Frequency of Test	Purpose of test	Reference
59	Permeability test on cement mortar	Once in a week		IS 3085-1965
60	Workability by Slump test	One test in each shift on at frequent intervals to checked workability	To finalise the water cement ratio	IS 1199-1959
61	Chemical Analysis on Cement (on all types)	For every Consignment	To verify the composition of Cement as specified in the IS	IS-4032-1985 IS 269-1989 IS 8112-1989 IS 12269-1987 IS 1489-1991 IS 12600-1989
62	Chemical Analysis on Fine Aggregates	For every Consignment	To determine the corrosive nature of fine aggregates and to find adulteration	1. IS 2720 XXI 2. IS 2720 XXII 3. IS 2720-XXVI 4. IS 2720 - XXVII
63	Chemical Analysis of Water for construction purposes	Every Source and also reassessing during summer	To find the suitability of water for construction purposes	As per IS 456 – 2000
64	Mix proportion on Hardened Concrete by Chemical Analysis	Random during execution	To confirm that approved mix design is followed by the Field Engineers	As per IS 1199 - 1959
	<p>Note:</p> <ol style="list-style-type: none"> The above frequency of testing are indicative only, however the Engineer in charge of the Execution (Executive Engineer in charge of the execution) on his discretion may increase the frequency of testing based on field conditions. The Engineer in charge of the Execution (Executive Engineer in charge of the execution) is the authority to finalise the total number of tests to be carried out in each Package. 			